JC03 Rec'd PCT/PTO 19 JUN 2001

FORM PTO-1390 (REV. 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER **10537/105**
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/868597
INTERNATIONAL APPLICATION NO. **PCT/DE99/04017**	INTERNATIONAL FILING DATE **(17.12.99) 17 December 1999**	PRIORITY DATES CLAIMED **(22.12.98) 22 December 1998**

TITLE OF INVENTION
WEAR-RESISTANT LAYER

APPLICANT(S) FOR DO/EO/US
SAGEL, Alexander; KOPPERGER, Bertram; BAYER, Erwin and SMARSLY, Wilfried

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unexecuted)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☒ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: An English translation of the International Search Report; Marked-up version of the Substitute Specification; three (3) sheets of formal drawings and first page of the published International Application WO 00/37713.

EXPRESS MAIL NO. : EL327551186US

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U.S. APPLICATION NO. (if known, see 37 C.F.R.1.5) 09/868597	INTERNATIONAL APPLICATION NO PCT/DE99/04017	ATTORNEY'S DOCKET NUMBER 10537/105

17. ☒ The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO . . . . $860.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) . . . $690.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) . . . . $710.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO . . . . $1,000.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate	CALCULATIONS	PTO USE ONLY
Total Claims	16 - 20 =	0	X $18.00	$	
Independent Claims	1 - 3 =	0	X $80.00	$	
Multiple dependent claim(s) (if applicable)			+ $270.00		
TOTAL OF ABOVE CALCULATIONS =				$ 860.00	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$ 860.00	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 860.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$ 860.00	
				Amount to be: refunded	$
				charged	$ 860.00

a. ☐ A check in the amount of $________ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of **$860.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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New York, New York 10004

26646
PATENT TRADEMARK OFFICE

R. L. Mayer
SIGNATURE

Richard L. Mayer, Reg. No. 22,490
NAME

6/19/01
DATE

NY01 384471 v 1

[10537/105]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s)	:	Alexander SAGEL et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	WEAR-RESISTANT LAYER
Examiner	:	To Be Assigned
Art Unit	:	To Be Assigned

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT AND
37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

S I R:

Kindly amend the above-captioned application before examination, as set forth below.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

On the first page of the claims, first line, change "Patent Claims" to --WHAT IS CLAIMED IS:--.

Please cancel, without prejudice, claims 1 to 16 in the underlying PCT application. Please also cancel, without prejudice, claims 1 to 15 in the annex to the International Preliminary Examination Report.

Please add the following new claims:

--16. (New) A component, comprising:

a wear-resistant layer applied to a surface of the component to be protected, the surface being subjected to at least one of a mechanical load and a fluidic load, the layer including at least one of amorphous metals and amorphous-nanocrystalline metals, the layer including at least one rare earth metal, a transition metal and at least one of a Cu-Al-Ti alloy, a Cu-Al-Ta alloy, a Cu-Al-Zr alloy, a Pt-Al-Si alloy and a Ta-Si-N alloy.

17. (New) The component according to claim 16, wherein the transition metal includes one of Cu, Ni and Co.

18. (New) The component according to claim 16, wherein the layer is applied to the surface by electrodeposition.

19. (New) The component according to claim 16, wherein the layer is applied to the surface from a melt.

20. (New) The component according to claim 16, wherein the layer is applied to the surface by a PVD process.

21. (New) The component according to claim 16, wherein the layer is applied to the surface by thermal spraying.

22. (New) The component according to claim 16, wherein the component includes a component of an internal-combustion engine.

23. (New) The component according to claim 16, wherein the component includes a component of a gas turbine around which one of a gas and a hot gas flow.

24. (New) The component according to claim 16, wherein the component includes a blade of a gas turbine, the surface corresponding to at least a portion of a root of the blade, the layer being configured to protect against fretting.

25. (New) The component according to claim 16, wherein the component is formed of a fiber-reinforced plastic.

26. (New) The component according to claim 16, wherein the component includes at least one of a fiber-reinforced plastic blade and a support configured as one of a disc and a ring of an integrally bladed fiber-reinforced plastic rotor, the at least one of the blade and the support including the surface, the layer being configured to protect against at least one of erosion and corrosion.

27. (New) The component according to claim 16, wherein the layer is metallic.

28. (New) The component according to claim 27, wherein the layer further includes one of a Ti alloy, a Ni alloy, a Co alloy and a Fe alloy.

29. (New) The component according to claim 16, wherein the component includes a tire of a rail-borne vehicle, the tire including the surface.

30. (New) The component according to claim 16, wherein the component includes a component of a reciprocating engine, the component of the reciprocating engine including the surface.

31. (New) The component according to claim 30, wherein the component of the reciprocating includes one of a valve, a camshaft, a crankshaft, a piston ring and a piston pin.--.

REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1 to 16 in the underlying PCT Application No. PCT/DE99/04017. This Preliminary Amendment further cancels, without prejudice, claims 1 to 15 in the annex to the International Preliminary Examination Report and adds new claims 16 to 31. The new claims, inter alia, conform the claims to U.S. Patent and Trademark Office rules and do not add any new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(iii) and 1.125(b)(2), a Marked Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/DE99/04017 includes an International Search Report, dated May 22, 2000, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

The underlying PCT Application No. PCT/DE99/04017 also includes an International Preliminary Examination Report dated December 22, 2000, an English translation of the annexed pages thereto are enclosed herewith.

It is respectfully submitted that the subject matter of the present application is new, non-obvious and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

KENYON & KENYON

Dated: 6/19/01

By: Richard L. Mayer
~~Reg.~~ No. 22,490

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[10537/105]

WEAR-RESISTANT LAYER

FIELD OF THE INVENTION

The present invention relates to a wear-resistant layer which is applied to a surface, which is to be protected, of a component which is subjected to mechanical and/or fluidic loads and substantially comprises amorphous or amorphous-nanocrystalline metals.

BACKGROUND INFORMATION

Components which are subjected to mechanical stresses from friction or around which media flow are generally subject to abrasive or erosive wear. In the field of internal-combustion engines, this wear occurs, for example in the case of piston engines, on valves, pistons or the like. In the field of gas turbines, furthermore, the components around which media flow need to be protected against erosion and corrosion.

The journal Metall, volume 36 (August 1982), pages 841 to 853, describes welding amorphous metal strips, due to their corrosion resistance and their high hardness and resistance to abrasion, to turbine blades of aircraft engines. Amorphous iron-base metals and the production of the metal strips using continuous quenching methods may be used for this purpose.

German Published Patent Application No. 38 00 454 describes a process for the production of corrosion-resistant and wear-resistant layers and shaped bodies made from metallic, amorphous materials, in which an amorphous powder which can be processed further by powder metallurgy is produced from metallic alloys, and this powder is then applied to the substrate, for example, by plasma spraying.

German Published Patent Application No. 38 14 444 describes amorphous alloys which are highly resistant to corrosion and substantially comprise at least one element selected from the

group consisting of Ta and Nb and in addition may have at least one element selected from the group consisting of Ti and Zr, with Cu also always being a constituent. Numerous Cu-base alloys made from these elements are described, and these alloys are applied to a substrate by spray deposition.

German Published Patent Application No. 42 16 150 describes highly corrosion-resistant amorphous alloys based on Ti or Zr and Cr, which are described as having a high resistance to corrosion and wear and are applied to a substrate by sputtering or atomization.

German Published Patent Application No. 689 03 073 describes a thin, corrosion-resistant and heat-resistant film made from an aluminium alloy and a process for its production, in which the alloy contains, as further elements, Ni, Zr or Y and is applied by thin-film formation techniques, such as cathode sputtering, vacuum deposition or ion plating, to a substrate, such as, for example, a wire or a filament.

U.S. Patent No. 5,389,226 describes electrodeposition of an amorphous microcrystalline (including nanocrystalline) Ni-W alloy on a substrate, such as a part of an internal-combustion engine, the coating having a high hardness and being able to withstand wear and corrosion.

Japanese Published Patent Application No. 10096077 describes a gradient coating with a thickness of over 0.1 mm which is produced from an Al alloy, an element selected from the group consisting of Cr, Mn, Fe, Co, Ni, Cu, Ti, Zr and Y, rare earths and a misch metal by electron beam deposition on a substrate, the hardness of the coating being varied by the ratio between Al and the element from the group.

Chemical Abstracts XP002136889 describes the coating of a copper wire, which has a first, amorphous layer of an Ni-P alloy, with an amorphous Pd-Cu-Si alloy by a laser, by which

electrical contact elements are describes as becoming better able to withstand dissolution and abrasion.

It is an object of the present invention to provide a wear-resistant layer, which protects component surfaces that are acted on mechanically, for example, by friction, or fluidically against wear and increases the service life of these components. Suitable alloys are provided.

According to the present invention, the layer comprises an alloy based on Cu-Al-Ti(or -Ta or -Zr) or Pt-Al-Si or Ta-Si-N, at least one rare earth and a transition metal, such as Cu or Ni or Co.

The advantage of wear-resistant layers of this type is that their alloys, unlike conventional crystalline metals, due to their amorphous or vitreous structure, do not have any grain boundaries and therefore have a high resistance to abrasive or erosive wear and have a high elastic restoring capacity.

In one example embodiment of the present invention, the layer substantially comprises an Ni-W-base alloy, in which case the alloy may be Ni-rich and contain only between 20 and 40 atomic % of W. To achieve the amorphous or amorphous-nanocrystalline metal structure, the alloy may inexpensively be electrodeposited on the surface of the component to be coated. An alloy of this type which is present in the form of amorphous or amorphous-nanocrystalline metal has a high hardness, in particular due to the element W, and is extremely wear-resistant and temperature-resistant.

In an alternative example embodiment of the present invention, the wear-resistant layer may substantially comprise an alloy based on Cu-Al-Ti (or -Ta or -Zr) or Pt-Al-Si or Ta-Si-N, in which case the layer may be applied to the surface of the component by PVD (physical vapor deposition) processes, and in

particular Ta-Si-N is suitable for applications at elevated temperatures.

The wear-resistant layer may substantially comprise an alloy based on Zr-Ti, in which case the amorphous or amorphous and nanocrystalline metal structure is produced by applying the alloy from the melt.

Alternatively, the wear-resistant layer may substantially comprise an alloy based on Fe-Cr-B, in which case the alloy is preferably iron-rich and contains approximately 70 atomic % of Fe. A wear-resistant layer of this type may be applied to the surface of the component by, for example, thermal spraying processes.

In a further example embodiment of the present invention, the wear-resistant layer may substantially comprise an alloy of Al, at least one rare earth and a transition metal, such as for example Cu or Ni or Co.

The layer may be applied to the root of a blade of a gas turbine to protect against fretting, since in that region, while the gas turbine is operating, a high level of frictional wear with high-frequency alternating loads with low amplitudes occurs.

In another example embodiment of the present invention, the wear-resistant layer may be applied to a component which substantially comprises fiber-reinforced plastic (FRP), in order to protect this component against erosion. In the case of FRP blades for compressors of gas turbines, examples of conventional arrangements for protecting against erosion are metallic foils, felts, wire meshes or coating materials, which have drawbacks in terms of the manufacturing costs or the required service life and are not yet usable.

In an alternative example embodiment of the present invention, the wear-resistant layer may be applied to a rotor carrier or rotor ring, which is configured as a disc or a ring, of an integrally bladed FRP rotor of a gas turbine, as protection against abrasive and/or erosive wear.

In an alternative use, the wear-resistant layer is applied to a component of a reciprocating engine, such as, for example, a valve, a camshaft, a crankshaft, a piston ring or a piston pin.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically illustrates the structure of an amorphous metal.

Fig. 2 schematically illustrates the structure of an amorphous and nanocrystalline or partially crystalline metal.

Fig. 3 is a schematic perspective view of an FRP blade with an example embodiment of the wear-resistant layer according to the present invention.

Fig. 4 is a schematic perspective view of a metallic blade with an alternative example embodiment of the wear-resistant layer according to the present invention.

Fig. 5 is a schematic perspective view of an FRP rotor with a further alternative example embodiment of the wear-resistant layer according to the present invention.

DETAILED DESCRIPTION

Fig. 1 schematically illustrates the microstructure of an amorphous metal, in which the elements are not, as is the case of Ti, for example, arranged in a fixed, crystalline structure, but rather are arranged randomly without a regular crystal lattice (region 1). The grain boundaries which are absent result in amorphous or amorphous and nanocrystalline

metals having a high resistance to wear and a high Vickers hardness. Moreover, unlike crystalline metals, there is no embrittlement and strain hardening.

Fig. 2 schematically illustrates the structure of an amorphous and nanocrystalline or partially crystalline metal, in which the elements are in part arranged randomly in an amorphous structure (region 1) and in part are in the form of relatively small regions with a crystalline structure (region 2). Amorphous and nanocrystalline or partially crystalline metals of this type also have a high resistance to abrasive or erosive wear and have a high Vickers hardness.

Fig. 3 is a schematic perspective view of a blade of a gas turbine which is denoted overall by 3 and in which a blade 4 consists of fiber-reinforced plastic and is attached to a metallic blade root 5 consisting of a Ti-base alloy. A blade 3 of this type is used, for example, in a compressor, and its blade root 5 is attached to a rotor ring or rotor carrier releasably or alternatively integrally using a suitable welding process. The fact that the blade 4 is formed from fiber-reinforced plastic has proven advantageous in reducing weight. However, drawbacks include the material's generally inadequate wear resistance to erosion. For this reason, the blade 4 made from fiber-reinforced plastic is completely provided with a wear-resistant layer 6, which substantially comprises amorphous or amorphous and nanocrystalline metals.

In the present configuration, an alloy which substantially comprises Ni-W, is Ni-rich and contains approximately 30 atomic % of W is selected. To form the amorphous or amorphous and nanocrystalline structure, the alloy is applied to the surface of the blade 4 made from carbon fiber-reinforced plastic by electrodeposition. The mechanical properties and the wear resistance of the wear-resistant layer 6 may be set using the parameters temperature, voltage and chemistry of the electrodeposition bath. The hardness of the wear-resistant

layer 6 may also be increased by a final heat treatment at temperatures between approximately 100°C and 500°C. Alternatively, it is also possible for only individual sections of the blade 3, such as the leading edge or the blade tip, to be provided with the wear-resistant layer 6. This layer may also consist of an alloy based on Cu-Al-Ti (or -Ta or -Zr) or Pd-Cu-Si or Pt-Al-Si or Pa-Si-N, since these alloys, in particular in combination with their amorphous or amorphous-nanocrystalline metal structure, are wear-resistant, hard and temperature-resistant.

Fig. 4 illustrates a metallic (rotor) blade 7 of a compressor of a gas turbine which has a blade root 8 with a fir-tree profile 9 for releasable attachment to a rotor. The blade is produced by powder metallurgy from Ti-Al. Alternatively, the wear-resistant layer 6 may also be applied to cast or forged blades or other components of a gas turbine. While the gas turbine is operating, fretting often occurs at the root 8 of the blade 7. To avoid the resultant wear and therefore to increase the service life, the blade 7 is protected at its root 8 and in particular in the region of the fir-tree profile 9 with a wear-resistant layer 6 which substantially comprises amorphous or amorphous-nanocrystalline metals. The wear-resistant layer 6 substantially comprises an alloy based on Pd-Cu-Si and is applied to that surface of the blade root 8 which is to be protected against fretting by a PVD process. In addition to its mechanical properties, a wear-resistant layer 6 of this type is also distinguished by its resistance to oxidation. For applications at elevated temperatures, the wear-resistant layer 6 may alternatively consist of an alloy based on Ta-Si-N.

In the present application illustrated in Fig. 4, as an alternative a wear-resistant layer 6 comprising amorphous or amorphous-nanocrystalline metals and made from an alloy based on Fe-Cr-B is also possible, this layer being iron-rich and containing approximately 70 atomic % of Fe. The desired

structure of this alloy, which is amorphous at least in regions, may be established during application by thermal spraying.

Fig. 5 illustrates an integrally bladed rotor 10 of a gas turbine, to the circumferential surface 11 of which a plurality of blades 12, which are generally arranged equidistantly and extend substantially in the radial direction, are attached. A rotor 10 of this type is produced, for example, integrally from carbon fiber-reinforced plastic and has a poor resistance to wear. To improve the resistance to abrasive and erosive wear during operation, the rotor 10 is provided with a wear-resistant layer 6 made from an Ni-W-base alloy, which is Ni-rich, contains approximately 35 atomic % of W and, to form the amorphous or amorphous-nanocrystalline structure, is produced on the surface of the rotor 10 by electrodeposition.

Alternatively, the rotor 10 may, at the abovementioned regions, be coated with a layer 6 of an alloy of Al, at least one rare earth and a transition metal, such as Cu or Ni or Co, since these alloys, in combination with their amorphous or amorphous-nanocrystalline metal structure, are wear-resistant and temperature-resistant.

ABSTRACT

A wear-resistant layer is applied to a surface, which is to be protected, of a component which is subjected to mechanical and/or fluidic loads and substantially consists of amorphous or amorphous-nanocrystalline metals. The layer for protecting against abrasive or erosive wear substantially consists of an Ni-W-base alloy or substantially consists of an alloy based on Cu-Al-Ti (or -Ta or -Zr) or Pd-Cu-Si or Pt-Al-Si or Ta-Si-N, or substantially consists of an alloy of Al, at least one rare earth and a transition metal, such as Cu or Ni or Co.

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WEAR-RESISTANT LAYER

FIELD OF THE INVENTION

The **present** invention relates to a wear-resistant layer which is applied to a surface, which is to be protected, of a component which is subjected to mechanical and/or fluidic loads and substantially comprises amorphous or amorphous-nanocrystalline metals.

BACKGROUND INFORMATION

Components which are subjected to mechanical stresses from friction or around which media flow are generally subject to abrasive or erosive wear. In the field of internal-combustion engines, this wear occurs, for example in the case of piston engines, on valves, pistons or the like. In the field of gas turbines, furthermore, the components around which media flow need to be protected against erosion and corrosion.

[It is known from] **The** journal Metall, volume 36 (August 1982), pages 841 to 853, [to weld] **describes welding** amorphous metal strips, [on account of] **due to** their [good] corrosion resistance and their high hardness and resistance to abrasion, to turbine blades of aircraft engines[;]**.** [amorphous] **Amorphous** iron-base metals and the production of the metal strips using continuous quenching methods [are proposed] **may be used** for this purpose.

[De] **German Published Patent Application No.** 38 00 454 [A1 has disclosed] **describes** a process for the production of corrosion-resistant and wear-resistant layers and shaped bodies made from metallic, amorphous materials, in which [first of all] an amorphous powder which can be processed further by powder metallurgy is produced from metallic alloys,

and this powder is then applied to the substrate, for example, by plasma spraying.

[DE] **German Published Patent Application No.** 38 14 444 [A1 has disclosed] **describes** amorphous alloys which are highly resistant to corrosion and substantially comprise at least one element selected from the group consisting of Ta and Nb and in addition may have at least one element selected from the group consisting of Ti and Zr, with Cu also always being a constituent. Numerous Cu-base alloys made from these elements are [disclosed] **described**, and these alloys are applied to a substrate by spray deposition.

[DE] **German Published Patent Application No.** 42 16 150 [A1 discloses] **describes** highly corrosion-resistant amorphous alloys based on Ti or Zr and Cr, which are [said to have] **described as having** a high resistance to corrosion and wear and are applied to a substrate by sputtering or atomization.

[DE] **German Published Patent Application No.** 689 03 073 [T2 has disclosed] **describes** a thin, corrosion-resistant and heat-resistant film made from an aluminium alloy and a process for its production, in which the alloy contains, as further elements, Ni, Zr or Y and is applied by thin-film formation techniques, such as cathode sputtering, vacuum deposition or ion plating, to a substrate, such as, for example, a wire or a filament.

U.S. Patent No. 5,389,226 describes electrodeposition of an amorphous microcrystalline (including nanocrystalline) Ni-W alloy on a substrate, such as a part of an internal-combustion engine, the coating having a high hardness and being able to withstand wear and corrosion.

Japanese Published Patent Application No. 10096077 describes a gradient coating with a thickness of over 0.1 mm which is produced from an Al alloy, an element selected from the group consisting of Cr, Mn, Fe, Co, Ni, Cu, Ti, Zr and Y, rare earths and a misch metal by electron beam deposition on a substrate, the hardness of the coating being varied by the ratio between Al and the element from the group.

Chemical Abstracts XP002136889 describes the coating of a copper wire, which has a first, amorphous layer of an Ni-P alloy, with an amorphous Pd-Cu-Si alloy by a laser, by which electrical contact elements are describes as becoming better able to withstand dissolution and abrasion.

[The problem on which the] **It is an object of the present** invention [is based consists in providing] **to provide** a wear-resistant layer [of the generic type described in the introduction], which protects component surfaces [which] **that** are acted on mechanically, for example, by friction, or fluidically against wear and increases the service life of these components. Suitable alloys are [to be] provided [for this purpose].

According to the **present** invention, [the solution to this problem is characterized in that] the layer [substantially comprises an Ni-W-base alloy or substantially] comprises an alloy based on Cu-Al-Ti(or -Ta or -Zr) or [Pd-Cu-Si or] Pt-Al-Si or Ta-Si-N, [or substantially comprises an alloy of Al,] at least one rare earth and a transition metal, such as Cu or Ni or Co.

The advantage of wear-resistant layers of this type is that their alloys, unlike conventional crystalline metals, [on account of] **due to** their amorphous or vitreous structure, do not have any grain boundaries and therefore [on the one hand]

have a high resistance to abrasive or erosive wear and [on the other hand] have a high elastic restoring capacity.

In one [configuration] **example embodiment** of the **present** invention, the layer substantially comprises an Ni-W-base alloy, in which case the alloy may be Ni-rich and contain only between 20 and 40 atomic % of W. To achieve the amorphous or [amorphous and nanocrystalline] **amorphous-nanocrystalline** metal structure, the alloy may inexpensively be electrodeposited on the surface of the component to be coated. An alloy of this type which is present in the form of amorphous or amorphous-nanocrystalline metal has a high hardness, in particular [on account of] **due to** the element W, and is extremely wear-resistant and temperature-resistant.

In an alternative [configuration] **example embodiment of the present invention**, the wear-resistant layer may substantially comprise an alloy based on Cu-Al-Ti (or -Ta or -Zr) or [Pd-Cu-Si or] Pt-Al-Si or Ta-Si-N, in which case the layer [can] **may** be applied to the surface of the component by [means of] PVD (physical [vapour] **vapor** deposition) processes, and in particular Ta-Si-N is suitable for applications at elevated temperatures.

The wear-resistant layer may substantially comprise an alloy based on Zr-Ti, in which case the amorphous or amorphous and nanocrystalline metal structure is produced by applying the alloy from the melt.

Alternatively, the wear-resistant layer may substantially comprise an alloy based on Fe-Cr-B, in which case the alloy is preferably iron-rich and contains approximately 70 atomic % of Fe. A wear-resistant layer of this type may be applied to the surface of the component by, for example, thermal spraying processes.

In a further [configuration] **example embodiment** of the **present** invention, the wear-resistant layer may substantially comprise an alloy of Al, at least one rare earth and a transition metal, such as for example Cu or Ni or Co.

The layer [is preferably] **may be** applied to the root of a blade of a gas turbine to protect against fretting, since in that region, while the gas turbine is operating, a high level of frictional wear with high-frequency alternating loads with low amplitudes occurs.

In another [configuration] **example embodiment of the present invention**, the wear-resistant layer may be applied to a component which substantially comprises [fibre-reinforced] **fiber-reinforced** plastic (FRP), in order to protect this component against erosion. In the case of FRP blades for compressors of gas turbines, examples of [known means] **conventional arrangements** for protecting against erosion are metallic foils, felts, wire meshes or coating materials, which have drawbacks in terms of the manufacturing costs or the required service life and are not yet usable.

In an alternative [exemplary] **example** embodiment **of the present invention**, the wear-resistant layer may be applied to a rotor carrier or rotor ring, which is [designed] **configured** as a disc or a ring, of an integrally bladed FRP rotor of a gas turbine, as protection against abrasive and/or erosive wear.

In an alternative use, the wear-resistant layer is applied to a component of a reciprocating engine, such as, for example, a valve, a camshaft, a crankshaft, a piston ring or a piston pin.

[Further configurations of the invention are described in the subclaims.

In the text which follows, the invention is explained in more detail on the basis of exemplary embodiments and with reference to a drawing, in which:]

BREIF DESCRIPTION OF THE DRAWINGS

Fig. 1 [diagrammatically depicts] **schematically illustrates** the structure of an amorphous metal[,]**.**

Fig. 2 [diagrammatically depicts] **schematically illustrates** the structure of an amorphous and nanocrystalline or partially crystalline metal[,]**.**

Fig. 3 [shows] **is** a [diagrammatic and] **schematic** perspective view of an FRP blade with an [exemplary] **example** embodiment of the wear-resistant layer according to the **present** invention[,]**.**

Fig. 4 [shows] **is** a [diagrammatic and] **schematic** perspective view of a metallic blade with an alternative [exemplary] **example** embodiment of the wear-resistant layer according to the **present** invention[, and]**.**

Fig. 5 [shows] **is** a [diagrammatic and] **schematic** perspective view of an FRP rotor with a further alternative [exemplary] **example** embodiment of the wear-resistant layer according to the **present** invention.

DETAILED DESCRIPTION

Fig. 1 [diagrammatically depicts] **schematically illustrates** the microstructure of an amorphous metal, in which the elements are not, as is the case [with] **of** Ti, for example, arranged in a fixed, crystalline structure, but rather are

arranged randomly without a regular crystal lattice (region 1). The grain boundaries which are absent [as a] result [lead to] **in** amorphous or amorphous and nanocrystalline metals having a high resistance to wear and a high Vickers hardness. Moreover, unlike [with the] crystalline metals, there is no embrittlement and strain hardening.

Fig. 2 [diagrammatically depicts] **schematically illustrates** the structure of an amorphous and nanocrystalline or partially crystalline metal, in which the elements are in part arranged randomly in an amorphous structure (region 1) and in part are in the form of relatively small regions with a crystalline structure (region 2). Amorphous and nanocrystalline or partially crystalline metals of this type also have a high resistance to abrasive or erosive wear and have a high Vickers hardness.

Fig. 3 [shows] **is** a [diagrammatic and] **schematic** perspective view of a blade of a gas turbine which is denoted overall by 3 and in which a blade 4 consists of [fibre-reinforced **fiber-reinforced** plastic and is attached to a metallic blade root 5 consisting of a Ti-base alloy. A blade 3 of this type is used, for example, in a compressor**,** and its blade root 5 is attached to a rotor ring or rotor carrier releasably or alternatively integrally using a suitable welding process. The fact that the blade 4 is formed from [fibre-reinforced] **fiber-reinforced** plastic has proven advantageous [with a view to] **in** reducing weight. However, drawbacks include the material's generally inadequate wear resistance to erosion. For this reason, the blade 4 made from [fibre-reinforced] **fiber-reinforced** plastic is completely provided with a wear-resistant layer 6, which substantially comprises amorphous or amorphous and nanocrystalline metals.

In the present configuration, an alloy which substantially comprises Ni-W, is Ni-rich and contains approximately 30

atomic % of W is selected. To form the amorphous or amorphous and nanocrystalline structure, the alloy is applied to the surface of the blade 4 made from carbon [fibre-reinforced] **fiber-reinforced** plastic by electrodeposition. The mechanical properties and the wear resistance of the wear-resistant layer 6 [can] **may** be set using the parameters temperature, voltage and chemistry of the electrodeposition bath. [In particular, the] **The** hardness of the wear-resistant layer 6 [can] **may** also be increased by a final heat treatment at temperatures between approximately 100°C and 500°C. Alternatively, it is also possible for only individual sections of the blade 3, such as the leading edge or the blade tip, to be provided with the wear-resistant layer 6. This layer [could] **may** also consist of an alloy based on Cu-Al-Ti (or -Ta or -Zr) or Pd-Cu-Si or Pt-Al-Si or Pa-Si-N, since these alloys, in particular in combination with their amorphous or amorphous-nanocrystalline metal structure, are wear-resistant, hard and temperature-resistant.

Fig. 4 [shows] **illustrates** a metallic (rotor) blade 7 of a compressor of a gas turbine which has a blade root 8 with a fir-tree profile 9 for releasable attachment to a rotor. The blade is produced by powder metallurgy from Ti-Al. Alternatively, the wear-resistant layer 6 [could] **may** also be applied to cast or forged blades or other components of a gas turbine. While the gas turbine is operating, fretting often occurs at the root 8 of the blade 7. To avoid the resultant wear and therefore to increase the service life, the blade 7 is protected at its root 8 and in particular in the region of the fir-tree profile 9 with a wear-resistant layer 6 which substantially comprises amorphous or amorphous-nanocrystalline metals. The wear-resistant layer 6 substantially comprises an alloy based on Pd-Cu-Si and is applied to that surface of the blade root 8 which is to be protected against fretting by a PVD process. In addition to its [good] mechanical properties, a wear-resistant layer 6 of this type is also distinguished by

[a good] **its** resistance to oxidation. For applications at elevated temperatures, the wear-resistant layer 6 may alternatively consist of an alloy based on Ta-Si-N.

In the present application [shown] **illustrated** in Fig. 4, as an alternative a wear-resistant layer 6 comprising amorphous or amorphous-nanocrystalline metals and made from an alloy based on Fe-Cr-B is also [suitable] **possible**, this layer being iron-rich and containing approximately 70 atomic % of Fe. The desired structure of this alloy, which is amorphous at least in regions, [can] **may** be established during application by thermal spraying.

Fig. 5 [shows] **illustrates** an integrally bladed rotor 10 of a gas turbine, to the circumferential surface 11 of which a plurality of blades 12, which are generally arranged equidistantly and extend substantially in the radial direction, are attached. A rotor 10 of this type is produced, for example, integrally from carbon [fibre-reinforced] **fiber-reinforced** plastic and has a poor resistance to wear. To improve the resistance to abrasive and erosive wear during operation, the rotor 10 is provided with a wear-resistant layer 6 made from an Ni-W-base alloy, which is Ni-rich, contains approximately 35 atomic % of W and, to form the amorphous or amorphous-nanocrystalline structure, is produced on the surface of the rotor 10 by electrodeposition.

Alternatively, the rotor 10 may, at the abovementioned regions, be coated with a layer 6 of an alloy of Al, at least one rare earth and a transition metal, such as Cu or Ni or Co, since these alloys, in combination with their amorphous or amorphous-nanocrystalline metal structure, are wear-resistant and temperature-resistant.

[Abstract] **ABSTRACT**

A wear-resistant layer [which] is applied to a surface, which is to be protected, of a component which is subjected to mechanical and/or fluidic loads and substantially [comprises] **consists of** amorphous or amorphous-nanocrystalline metals[,]**.** [the] **The** layer [(6)] for protecting against abrasive or erosive wear substantially [comprising] **consists of** an Ni-W-base alloy or substantially [comprising] **consists of** an alloy based on Cu-Al-Ti(or -Ta or -Zr) or Pd-Cu-Si or Pt-Al-Si or Ta-Si-N, or substantially [comprising] **consists of** an alloy of Al, at least one rare earth and a transition metal, such as Cu or Ni or Co [(Fig.3)].

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WEAR-RESISTANT LAYER

The invention relates to a wear-resistant layer which is applied to a surface, which is to be protected, of a component which is subjected to mechanical and/or fluidic loads and substantially comprises amorphous or amorphous-nanocrystalline metals.

Components which are subjected to mechanical stresses from friction or around which media flow are generally subject to abrasive or erosive wear. In the field of internal-combustion engines, this wear occurs, for example in the case of piston engines, on valves, pistons or the like. In the field of gas turbines, furthermore, the components around which media flow need to be protected against erosion and corrosion.

It is known from the journal Metall, volume 36 (August 1982), pages 841 to 853, to weld amorphous metal strips, on account of their good corrosion resistance and their high hardness and resistance to abrasion, to turbine blades of aircraft engines; amorphous iron-base metals and the production of the metal strips using continuous quenching methods are proposed for this purpose.

De 38 00 454 A1 has disclosed a process for the production of corrosion-resistant and wear-resistant layers and shaped bodies made from metallic, amorphous materials, in which first of all an amorphous powder which can be processed further by powder metallurgy is produced from metallic alloys, and this powder is then applied to the substrate, for example by plasma spraying.

DE 38 14 444 A1 has disclosed amorphous alloys which are highly resistant to corrosion and substantially comprise at least one element selected from the group consisting of Ta and Nb and in addition may have at least one element selected from the group consisting of Ti and Zr, with Cu also always being a constituent. Numerous Cu-base alloys made from these elements are disclosed, and these alloys are applied to a substrate by spray deposition.

DE 42 16 150 A1 discloses highly corrosion-resistant amorphous alloys based on Ti or Zr and Cr, which are said to have a high

resistance to corrosion and wear and are applied to a substrate by sputtering or atomization.

DE 689 03 073 T2 has disclosed a thin, corrosion-resistant and heat-resistant film made from an aluminium alloy and a process for its production, in which the alloy contains, as further elements, Ni, Zr or Y and is applied by thin-film formation techniques, such as cathode sputtering, vacuum deposition or ion plating, to a substrate, such as for example a wire or a filament.

US 5,389,226 has disclosed the electrodeposition of an amorphous, microcrystalline (including nanocrystalline) Ni-W alloy on a substrate, such as a part of an internal-combustion engine, the coating having a high hardness and being able to withstand wear and corrosion.

JP 10096077 A has disclosed a gradient coating with a thickness of over 0.1 mm which is produced from an Al alloy, an element selected from the group consisting of Cr, Mn, Fe, Co, Ni, Cu, Ti, Zr and Y, rare earths and a misch metal by electron beam deposition on a substrate, the hardness of the coating being varied by means of the ratio between Al and the element from the said group.

Chemical Abstracts XP002136889 has disclosed the coating of a copper wire, which has a first, amorphous layer of an Ni-P alloy, with an amorphous Pd-Cu-Si alloy by means of a laser, by means of which electrical contact elements are said to become better able to withstand dissolution and abrasion.

The problem on which the invention is based consists in providing a wear-resistant layer of the generic type described in the introduction, which protects component surfaces which are acted on mechanically, for example by friction, or fluidically against wear and increases the service life of these components. Suitable alloys are to be provided for this purpose.

According to the invention, the solution to this problem is characterized in that the layer comprises an alloy based on Cu-Al-Ti(or -Ta or -Zr) or Pt-Al-Si or Ta-Si-N, at least one rare earth and a transition metal, such as Cu or Ni or Co.

The advantage of wear-resistant layers of this type is that their alloys, unlike conventional crystalline metals, on account of their amorphous or vitreous structure, do not have any grain boundaries and therefore on the one hand have a high resistance to abrasive or erosive wear and on the other hand have a high elastic restoring capacity.

In a configuration which does not form part of the invention, the layer substantially comprises an Ni-W-base alloy, in which case the alloy may be Ni-rich and contain only between 20 and 40 atomic % of W. To achieve the amorphous or amorphous and nanocrystalline metal structure, the alloy may inexpensively be electrodeposited on the surface of the component to be coated. An alloy of this type which is present in the form of amorphous or amorphous-nanocrystalline metal has a high hardness, in particular on account of the element W, and is extremely wear-resistant and temperature-resistant.

In an alternative configuration, the wear-resistant layer may substantially comprise an alloy based on Cu-Al-Ti (or -Ta or -Zr) or Pt-Al-Si or Ta-Si-N, in which case the layer can be applied to the surface of the component by means of PVD (physical vapour deposition) processes, and in particular Ta-Si-N is suitable for applications at elevated temperatures.

In an embodiment which does not form part of the invention, the wear-resistant layer may substantially comprise an alloy based on Zr-Ti, in which case the amorphous or amorphous and nanocrystalline metal structure is produced by applying the alloy from the melt.

Alternatively, in an embodiment which does not form part of the invention, the wear-resistant layer may substantially comprise an alloy based on Fe-Cr-B, in which case the alloy is preferably iron-rich and contains approximately 70 atomic % of Fe. A wear-resistant layer of this type may be applied to the surface of the component by, for example, thermal spraying processes.

In a further configuration which does not form part of the invention, the wear-resistant layer may substantially comprise an alloy of Al, at least one rare earth and a transition metal, such as for example Cu or Ni or Co.

The layer is preferably applied to the root of a blade of a gas turbine to protect against fretting, since in that region, while the gas turbine is operating, a high level of frictional wear with high-frequency alternating loads with low amplitudes occurs.

In another configuration, the wear-resistant layer may be applied to a component which substantially comprises fibre-reinforced plastic (FRP), in order to protect this component against erosion. In the case of FRP blades for compressors of gas turbines, examples of known means for protecting against erosion are metallic foils, felts, wire meshes or coating materials, which have drawbacks in terms of the manufacturing costs or the required service life and are not yet usable.

In an alternative exemplary embodiment, the wear-resistant layer may be applied to a rotor carrier or rotor ring, which is designed as a disc or a ring, of an integrally bladed FRP rotor of a gas turbine, as protection against abrasive and/or erosive wear.

In an alternative use, the wear-resistant layer is applied to a component of a reciprocating engine, such as for example a valve, a camshaft, a crankshaft, a piston ring or a piston pin.

Further configurations of the invention are described in the subclaims.

In the text which follows, the invention is explained in more detail on the basis of exemplary embodiments and with reference to a drawing, in which:

Fig. 1 diagrammatically depicts the structure of an amorphous metal,

Fig. 2 diagrammatically depicts the structure of an amorphous and nanocrystalline or partially crystalline metal,

Fig. 3 shows a diagrammatic and perspective view of an FRP blade with an exemplary embodiment of the wear-resistant layer according to the invention,

Fig. 4 shows a diagrammatic and perspective view of a metallic blade with an alternative exemplary embodiment of the wear-resistant layer according to the invention, and

Fig. 5 shows a diagrammatic and perspective view of an FRP rotor with a further alternative exemplary embodiment of the wear-resistant layer according to the invention.

Fig. 1 diagrammatically depicts the microstructure of an amorphous metal, in which the elements are not, as is the case with Ti, for example, arranged in a fixed, crystalline structure, but rather are arranged randomly without a regular crystal lattice (region 1). The grain boundaries which are absent as a result lead to amorphous or amorphous and nanocrystalline metals having a high resistance to wear and a high Vickers hardness. Moreover, unlike with the crystalline metals, there is no embrittlement and strain hardening.

Fig. 2 diagrammatically depicts the structure of an amorphous and nanocrystalline or partially crystalline metal, in which the elements are in part arranged randomly in an amorphous structure (region 1) and in part are in the form of relatively small regions with a crystalline structure (region 2). Amorphous and nanocrystalline or partially crystalline metals of this type also have a high resistance to abrasive or erosive wear and have a high Vickers hardness.

Fig. 3 shows a diagrammatic and perspective view of a blade of a gas turbine which is denoted overall by 3 and in which a blade 4 consists of fibre-reinforced plastic and is attached to a metallic blade root 5 consisting of a Ti-base alloy. A blade 3 of this type is used, for example, in a compressor and its blade root 5 is attached to a rotor ring or rotor carrier releasably or alternatively integrally using a suitable welding process. The fact that the blade 4 is formed from fibre-reinforced plastic has proven advantageous with a view to reducing weight. However, drawbacks include the material's generally inadequate wear resistance to erosion. For this reason, the blade 4 made from fibre-reinforced plastic is completely provided with a wear-resistant layer 6, which substantially comprises amorphous or amorphous and nanocrystalline metals.

In the present configuration, an alloy which substantially comprises Ni-W, is Ni-rich and contains approximately 30 atomic % of W is selected. To form the amorphous or amorphous and nanocrystalline structure, the alloy is applied to the surface of the blade 4 made from carbon fibre-reinforced plastic by electrodeposition. The mechanical properties and the wear resistance of the wear-resistant layer 6 can be set using the parameters temperature, voltage and chemistry of the electrodeposition bath. In particular, the hardness of the wear-resistant layer 6 can also be increased by a final heat treatment at temperatures between approximately 100°C and 500°C. Alternatively, it is also possible for only individual sections of the blade 3, such as the leading edge or the blade tip, to be provided with the wear-resistant layer 6. This layer could also consist of an alloy based on Cu-Al-Ti (or -Ta or -Zr) or Pd-Cu-Si or Pt-Al-Si or Pa-Si-N, since these alloys, in particular in combination with their amorphous or amorphous-nanocrystalline metal structure, are wear-resistant, hard and temperature-resistant.

Fig. 4 shows a metallic (rotor) blade 7 of a compressor of a gas turbine which has a blade root 8 with a fir-tree profile 9 for releasable attachment to a rotor. The blade is produced by powder metallurgy from Ti-Al. Alternatively, the wear-resistant layer 6 could also be applied to cast or forged blades or other components of a gas turbine. While the gas turbine is operating, fretting often occurs at the root 8 of the blade 7. To avoid the resultant wear and therefore to increase the service life, the blade 7 is protected at its root 8 and in particular in the region of the fir-tree profile 9 with a wear-resistant layer 6 which substantially comprises amorphous or amorphous-nanocrystalline metals. The wear-resistant layer 6 substantially comprises an alloy based on Pd-Cu-Si and is applied to that surface of the blade root 8 which is to be protected against fretting by a PVD process. In addition to its good mechanical properties, a wear-resistant layer 6 of this type is also distinguished by a good resistance to oxidation. For applications at elevated temperatures, the wear-resistant layer 6 may alternatively consist of an alloy based on Ta-Si-N.

In the present application shown in Fig. 4, as an alternative a wear-resistant layer 6 comprising amorphous or amorphous-nanocrystalline metals and made from an alloy based on Fe-Cr-B is

also suitable, this layer being iron-rich and containing approximately 70 atomic % of Fe. The desired structure of this alloy, which is amorphous at least in regions, can be established during application by thermal spraying.

Fig. 5 shows an integrally bladed rotor 10 of a gas turbine, to the circumferential surface 11 of which a plurality of blades 12, which are generally arranged equidistantly and extend substantially in the radial direction, are attached. A rotor 10 of this type is produced, for example, integrally from carbon fibre-reinforced plastic and has a poor resistance to wear. To improve the resistance to abrasive and erosive wear during operation, the rotor 10 is provided with a wear-resistant layer 6 made from an Ni-W-base alloy, which is Ni-rich, contains approximately 35 atomic % of W and, to form the amorphous or amorphous-nanocrystalline structure, is produced on the surface of the rotor 10 by electrodeposition.

Alternatively, the rotor 10 may, at the abovementioned regions, be coated with a layer 6 of an alloy of Al, at least one rare earth and a transition metal, such as Cu or Ni or Co, since these alloys, in combination with their amorphous or amorphous-nanocrystalline metal structure, are wear-resistant and temperature-resistant.

Patent Claims

1. Coated component having a wear-resistant layer which is applied to a surface, which is to be protected, of the component which is subjected to mechanical and/or fluidic loads and substantially comprises amorphous or amorphous-nanocrystalline metals, characterized in that the layer (6) consists of an alloy based on Cu-Al-Ti or Cu-Al-Ta or Cu-Al-Zr or Pt-Al-Si or Ta-Si-N, at least one rare earth and a transition metal.

2. Component according to Claim 1, characterized in that the transition metal is Cu or Ni or Co.

3. Component according to one or more of the preceding claims, characterized in that the layer (6) is applied to the surface of the component by electrodeposition.

4. Component according to Claim 1 or 2, characterized in that the layer (6) is applied to the surface of the component from the melt.

5. Component according to Claim 1 or 2, characterized in that the layer (6) is applied to the surface of the component by means of the PVD process.

6. Component according to Claim 1 or 2, characterized in that the layer (6) is applied to the surface of the component by thermal spraying.

7. Component according to one or more of the preceding claims, characterized by a design as a component of an internal-combustion engine.

8. Component according to one or more of the preceding claims, characterized by a design as a component of a gas turbine around which gas or hot gas flows.

9. Component according to one or more of the preceding claims, characterized by a design as a blade (7) of a gas turbine, to the root (8,9) of which the layer (6) is applied in order to protect against fretting.

10. Component according to one or more of the preceding claims, characterized in that the component substantially comprises fibre-reinforced plastic (FRP).

11. Component according to one or more of the preceding claims, characterized by a design as an FRP blade (3,12) and/or a support, which is designed as a disc or a ring, of an integrally bladed FRP rotor (10), to which the layer (6) is applied in order to protect against erosion and/or corrosion.

12. Component according to one or more of Claims 1 to 9, characterized by a metallic design.

13. Component according to Claim 12, characterized by a design made from an alloy based on Ti or Ni or Co or Fe.

14. Component according to one or more of Claims 1 to 6, characterized by a design as a tyre of a rail-borne vehicle, to which the layer (6) is applied.

15. Component according to one or more of Claims 1 to 7, characterized by a design as a component of a reciprocating engine, such as a valve, a camshaft, a crankshaft, a piston ring or a piston pin, to which the layer (6) is applied.

Fig. 1

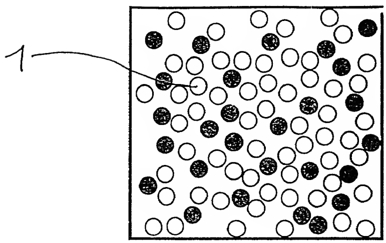


Fig. 2

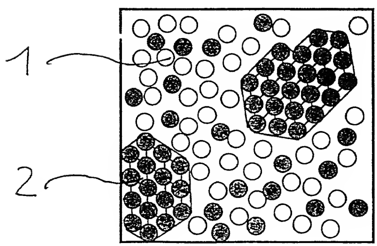


Fig. 3

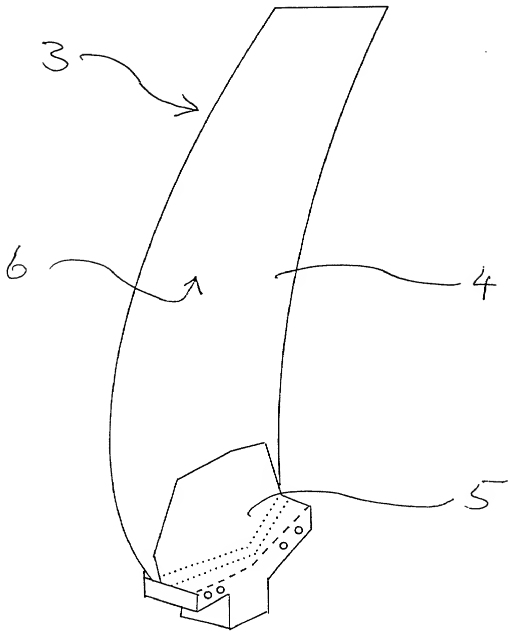


Fig. 4

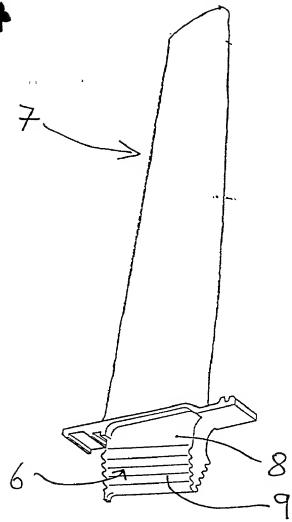
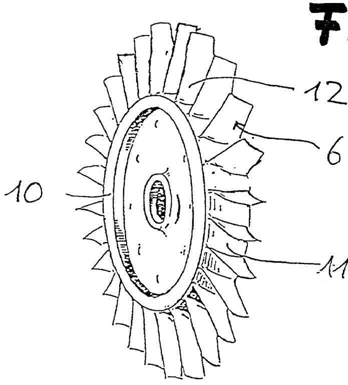


Fig. 5



DECLARATION AND POWER OF ATTORNEY

As below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter that is claimed and for which a patent is sought on the invention entitled **WEAR-RESISTANT LAYER**, the specification of which was filed as International Application No. PCT/DE99/04017, on December 17, 1999, an English translation of which is enclosed herewith.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims.

I acknowledge the duty to disclose information that is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate filed by me on the same subject matter having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

(Number)	(Country)	(Day/month/year filed)	Priority Claimed Under 35 USC 119	
198 59 477.1	Fed. Rep. of Germany	22 December 1998	Yes X	No _

And I hereby appoint Richard L. Mayer (Registration No. 22,490) my attorney with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Please address all communications regarding this application to:

KENYON & KENYON

26646

PATENT TRADEMARK OFFICE

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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